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ABSTRACT

Until recently, architects and school board trustees have been absorbed with the first order effects of science and technology -- i.e., the buildings produced. The side effects that have been ignored must now receive higher priority. Architects and engineers have tried to solve some technical problems by designing and constructing windowless or partly windowless public buildings. Although relatively satisfactory for adults, such a synthetic environment falls short of satisfying the psychological and physiological needs of young people. Windowless schools, for example, go contrary to the educational philosophy that the natural environment should be utilized in the education of young people. Research findings are cited, and the recommendation is made that each school design be studied by a multidisciplinary committee to assure provision of optimum human conditions. (Author)

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The Windowless School:

Some Biological and Economical Considerations.

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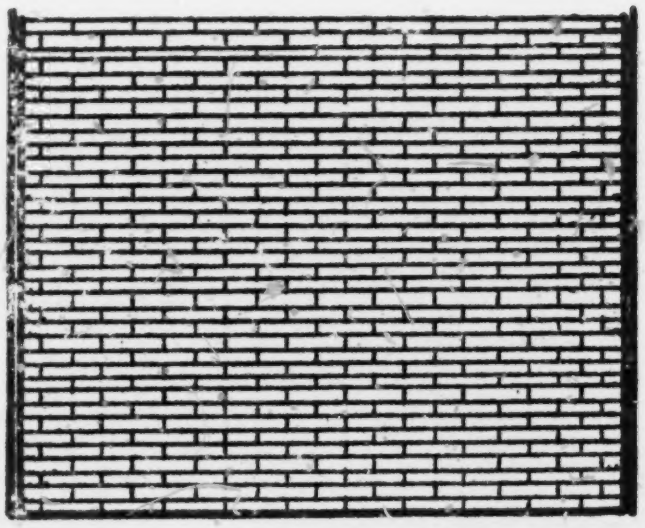

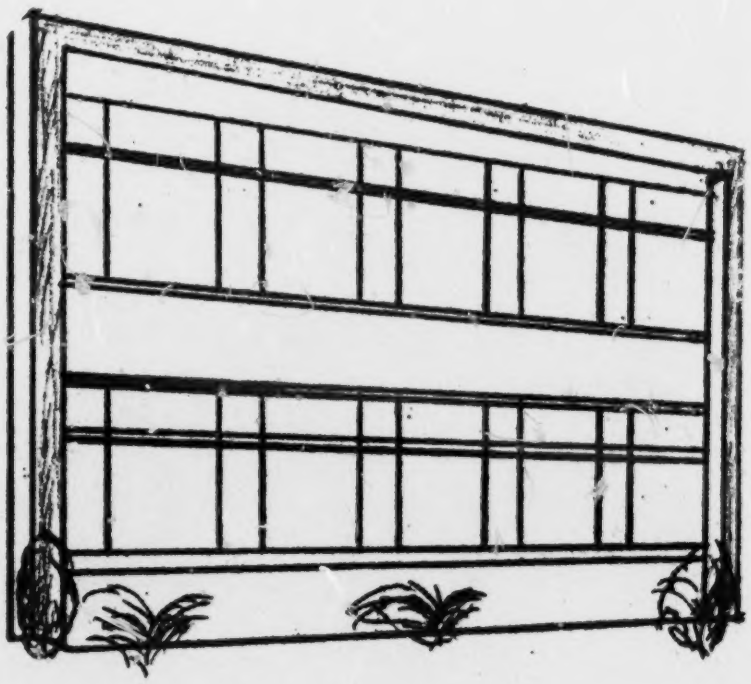

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" WE SHAPE OUR BUILDINGS,AND
AFTERWARDS OUR BUILDINGS SHAPE US."

Winston Churchill

This report represents the findings and opinions of the author only and should not be construed as representing a policy of a teachers' federation or a schoolboard.

Until recently architects and schoolboards trustees have been absorbed with the first-order effects of science and technology, namely the buildings produced.

The side effects were ignored.

Now a shift in values must be brought about: the control of side-effects must receive higher priority.

To assess the effects of new technologies and materials in school design the provincial Departments of School Planning and Building Research need staff with specialization in the areas of biology,biochemistry,arcology, biometeorology,psychology,education,the arts and landscape architecture.

B.J.VandenHazel.

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The Windowless Classroom.

Introduction

As an attempt to solve the educational,social, climatological,military or economic problems of specific areas in the U.S.A.,architects have designed the air-conditioned, artificially lighted,windowless school.

The arguments in favour of a windowless educational environment are stated as follows:

1.The absence of windows simplifies the construction,planning and lay-out of buildings.
2.Windows are expensive as they add to construction costs
as cleaning them requires manual labour
as vandalism requires replacement of panes
as winter heat-losses through panes of single glass are considerable
as they cause considerable heat-gain in summer.

3.The windowless classroom is free from disturbing visual and auditory influences from the outside that may distract students.

4.Constant temperatures and light intensity improve concentration and work output.

5.In some laboratory situations sunlight can ruin an experiment or even cause explosions.

6.Windowless classrooms facilitate the use of audio-visual equipment and increase the flexibility of seating arrangements.

7.The elimination of windows increases the size of blackboard and display areas.

The name "window" has been derived from the old Norse vind-auga or "wind-eye" and refers to the traditional functions of ventilation,light entrance and view to the outside.

The ventilating functions of windows can now be taken over by air-conditioning systems,while especially in North America,the emphasis has shifted from daylight illumination to artificial illumination.

Why then,are windows still added to schools,offices and homes? Are windows really needed for educational,psychological or physiological reasons?

The Artesia and Hobbs Schools in New Mexico

Artesia.

The board of education of the city of Artesia,N.M., has one underground elementary school,one windowless elementary school above ground and two elementary schools of traditional design.All four of these schools are located in an area of the city made up of middle to upper class families.

Dr. Frank W.Lutz,St Louis University,Missouri, was hired to study the effects of the educational environment and the educational results in these four elementary schools.(1)

These were his findings:

1. Our conclusions in the area of achievement,when other factors influencing achievement are held constant either statistically or matched,showed no apparent differences in the children from the four elementary schools in this study.

2. No significant differences in the four schools were found in any of the pupil behaviour indices.

3. The study indicates that children attending the underground school showed less anxiety than other children.

4. We conclude that the teachers in the different school environments were not exhibiting any difference in attitude or anxiety at the time of measurement.

5. The underground school has cost about $ 2.00 per square foot more than the conventional building in Artesia. (comment by author: the underground school has been built as a fall-out shelter)

Hobbs.

A study of three junior high schools,one windowless and thermally conditioned,two built along more traditional lines with broad expanses of windows and light shades in each classroom, suggests that students of equal ability and background will achieve about equally in either type of building.The students were given batteries of Stanford Achievement Tests.

It would seem that the decision whether to build a windowless school or the conventional type would have to depend not so much on student achievement but on aesthetic and other human needs.

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(1)"An Administrator Takes a Look at Windowless Buildings", George W.Reida,School Facilities Section,Kansas State Department of Public Instruction. 1964.

The Michigan Experiment

An environmental case-study published by the Architectural Research Laboratory of the University of Michigan (2) describes the behavioral reactions of both the teachers and the students in two primary schools during three distinct periods:

1. a school year in the existing fenestrated classrooms

2. a full year with all windows in the test school removed and

3. at least half a school year with the windows in the test unit restored.

In the test school opaque panels of asbestos-cement were substituted for the existing transparent dark-tinted glare-reducing Plexiglass window panels.

The immediate objective of the case-study was to find out,after the children in the test school had been deprived of an outside view for one whole school year,if there was any detectable difference in their learning achievements as compared with their previous work in the same building with fenestrated classrooms.

Most teachers after spending a full year in a windowless classroom,reported that they were no longer aware of the lack of windows and favored the arrangement as the children were no longer distracted by snow sleet,hail,strong winds and other weather conditions.Curiously enough,at the end of the experiment the teachers said to like the re-windowed classrooms "very much".

Although the case-study lacks medical or psychological evidence,it seems to indicate that no short-term harmful effects were noticed in students or teachers.

Neither did the windowless environment seem to have improved the learning achievement of the youngsters.

The case-study,unfortunately,did not try to measure the possible effects of the windowless environment on the endocrine system,the physiological clock and the eye development of the participating students.Neither is there any reference to the conditioning effects of the windowless classroom on the attitudes of the participants towards meteorological phenomena and man's dependence on the natural world.

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(2) The Effects of Windowless Classrooms on Elementary School Children, C.T.Carson,Publications Distribution Service, University of Michigan,1965.

The Religion of Economics

Most of the reasoning in favour of classrooms without windows,however, is based on economics. And a school design branded as uneconomic can,of course,not be considered by a schoolboard whose duty it is to provide education at the lowest possible cost. One may call a building ugly,soul destroying or a degradation of man,a peril to the physical or mental well-being of our future adults, but as long as one has not shown it to be uneconomic one has not really questioned the validity of the design.

Economic reasoning gives far more weight to the short-term than tc the long-term effects on people of say pollution and urban problems such as windowless work areas.It is characteristic of economic reasoning to ignore man's dependence on the natural world and its effects on his well-being. Economic reasoning keeps building designers from understanding that windowless buildings require a continuous and fantastically-large energy input for illumination and ventilation.This wasteful form of energy consumption will deplete our fossil fuels within one or two generations and adds considerably to air pollution problems. (see:The Global Consequences of Excessive Energy Consumption later in this study).

Dr.E.F.Schumacher in The Des Voeux Memorial Lecture at the annual conference of the National Society for Clean Air, Blackpool,England,stated in October 1967:

> "Instead of using economics as a useful,if narrowly specialized,tool modern society has embraced it as its primary religion, thereby laying itself open to dangers of an unprecedented kind" .

In the religion of economics the burden of proof is placed on those who take the ecological viewpoint.Therefore,unless biologists can produce evidence of injury to man urban deterioration will continue. But common sense should suggest that the burden of proof should lie on the designers and engineers who want to introduce windowless human zoos.It is they who must have evidence that the environment which they propose to create cannot have damaging mental and physiological effects on our young people.

Ralph and Mildred Buchsbaum,taking the ecological viewpoint, wrote:

> "An environmental setting developed by natural selection over many millions of years must be considered to have some merit ..... When information is incomplete,changes should stay close to the natural processes which have in their favour the indisputable evidence of having supported life for a very long time"(3)

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(3) Basic Ecology, Buchsbaum, The Boxwood Press,1957,p.20.

At the 1970 convention of Ontario architects some angry young men were rather critical of the lack of ecological awareness of many of their senior colleagues. One was quoted in the Globe and Mail of February 21,1970, p.B.2,as saying: "If there isn't more attention to ecology, we won't be alive in 10 years".

The author expresses the hope that this statement is slightly exaggerated and that mankind has about 30 years left to adapt itself to the natural forces which we are gradually beginning to understand.

It may be interesting to note that zoologists who have been comparing urban man and caged animals have found that the behaviour of zoo animals is much closer to that of humans than it is to that of animals in their natural environment. The caged animals share man's neurosis and other forms of aberrant behaviour. Desmond Morris warns urban planners and architects that the dehumanized buildings they permit are causing mental breakdown.(4)

Is it possible that windowless schools,offices and factories,as part of the synthetic urban environment, contribute to the chronic condition of neurosis and physiological disturbances which show up as degenerative diseases in young people long before they reach the prime of life?

Lewis Herber is convinced that " we are exchanging health for mere survival ..... in an increasingly distorted environment". (5) Herber explains how the overspecialization of the sciences has made possible many achievements in areas such as space science and medicine, but has at the same time discouraged a general investigation of public health problems.

The problems of our synthetic environment are intensified by the fact that non-human,usually economic, interests are given priority over basic human needs. The needs of industries are placed before the human need for clean air and low-intensity sounds and those of educational buildings before the students' need of privacy,territory, visual and mental relaxation and physical activity.

Students differ greatly in their reactions to environmental factors of schools and other institutions.Some are capable of a quick and complete adjustment,others are slow or unable to respond to the pressures of the school environment.While technology changes factors such as the quality of food and air and working conditions,medicine and psychiatry are expected to compensate.for the inability of large numbers of students to adapt themselves to 45 minute work sessions, lifeless artificial light,lack of physical activities,long locker-lined halls and an over emphasis on book learning.

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(4) The Human Zoo, Desmond Morris, Clarke Irwin,1969.
(5) Our Synthetic Environment,Lewis Herber,A.Knopf,N.Y. 1962.

The design of schools which may deprive young people,for periods ranging from six to eight hours per day, of all sensory contact with the natural environment seems like another instance where research in the natural and social sciences is lagging behind that of the physical sciences.Other contemporary examples of this lag are found in the belated control of drugs (thalidomide),insecticides (DDT),fungicides (mercury compounds),food additives,industrial pollution and urban transportation.

A panel of scientists convened by the U.S. National Academy of Sciences reported recently:

> "Rising concern over the imbalances that result (from pursuing technological developments) had led to a number of proposals to create what is plainly lacking in the economy: a mechanism whereby the broad effects of exploiting or restricting a technological development could be considered and effectively expressed" .(6)

It is clear that much research needs to be done on the development of an urban environment in which man conserves his physical and mental well-being. The North West European governments seem to be more concerned with the well-being of their students. The West German Federal Health Department issued a statement to schoolboards in 1969 that read in part:

> "The optical connection with the outdoors and proper ventilation through the windows is of great and proven significance for the psychological wellbeing of pupils and students. Artificial light must supplement daylight in such a way that the desired light intensity is guaranteed in all parts of the room".

H.C.Weston comments on the monotony of artificially-lit work areas:

> "The artificially lit environment,however, would probably always be more satisfying if the distribution of brightness within it could be continuously changed,without this change being distracting or causing the illumination on any work to be inadequate at any time". (7)

It must be mentioned,however,that lighting experts report very favourable teacher and student reactions to the windowless school in Kimberley,Wisc.(8) A survey conducted by Platzker (9) shows that windowless schools have been built in the U.S.A. but that there is considerable disagreement as to the merit of such structures.

(6)"The Assessment of Technology",Brooks and Bowers,Sc .American,Feb.197
(7)Sight,Light and Work,H.C.Weston,London,Lewis and Co.,1962,p.142.
(8)"Kimberley School Revisited",W.S.Fisher,Light,Vol 35,No.2,1966.
(9)"How much do we know about Windowless Schools?",J.Platzker, Better Light,Better Sight News,July-August 1966.

Windowless Schools and Fire Hazards

Windowless buildings have become popular with many architects as their construction constitutes a real technological challenge.Total energy equipment,air conditioning,artificial illumination and windowless spaces are used to create a synthetic environment which is expected to limit the attention of the occupants to the tasks at hand.

What are the effects of windowless construction on the safety of students and teachers?On the possible extent of fire damage to building and contents? And on the probable efficiency of fire department operations?

Fire records are filled with examples of rescues through windows of people trapped in open stairway buildings, including schools. Although new buildings are of fire-resistant construction,giving the owners a false sense of security, experience has proven that there is a gross lack of understanding of what constitutes a fire-safe building. It is interesting to note that many windowless classrooms in Ontario are not equipped with sprinkler systems.

Confinement of Heat and Smoke in a burning building helps to spread the fire within the building and interferes with access to the building.Windows are the primary means of ventilating buildings of heat and smoke.as they offer the quickest and most effective method of ventilating.Windowless buildings often demand longer hose lays through smoke and heat-filled corridors and stairways which increases the life safety hazards to fire fighters.

Losses from smoke and water damage are considerable in windowless buildings,because smoke and heat cannot get out and the firefighters cannot get in. It has become obvious that if windowless classrooms are not to become ovens when a fire starts inside,they must be protected by automatic extinguishing systems and automatic equipment to ventilate heat and smoke.

A fire in a windowless building poses frustrating problems to fire fighters. Finding a building filled with smoke and heat and with only one or two access doors,which are often locked and chained,they not only face the problem of finding access to the building but also the added difficulty of locating the source of the fire.

It would seem that windowless classrooms should be equipped with
- -properly installed and maintained sprinkler systems
- -automatic venting facilities
- -plentiful exits and emergency lighting
- -knockout panels for access by fire fighters
- -monitoring equipment to measure oxygen and carbon dioxide concentrations in corridors and classrooms.

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(10) "Fire Hazards of Windowless Buildings", E.E.Juilerat, Fire Record Department,National Fire Protection Association,1964.

The Functions of Light

Jacob and Stück base their objections to the windowless work environment on the latent physical and psychological damage to man due to the elimination of the natural rhythms of the day and man's forced adaptation to an artificial homeostasis of the environment.(11) Recent research on the anatomy of the optical nerves in man and in animals has clearly demonstrated that vision is not the only function of the eye. Light of various wavelengths and intensities affect not only the eye,but via the optic nerve,the midbrain and the pituitary gland also the central nervous system. The pituitary gland regulates hormonal secretions which in turn affect the metabolic processes such as digestion and oxidation.

In Brasilia,the new capital of Brazil,some of the office personnel work in completely windowless and air-conditioned buildings. Medical doctors report an unusually high incidence of psychosis,specifically feelings of persecution, and a high rate of turnover of office workers.

In a West German engineering research centre,an experiment was conducted with office personnel in windowless, air-conditioned and artificially illuminated rooms. It was found that people spending more than three hours daily in this controlled environment risked an upset of the digestive system. Jacob and Stück suggest,therefore,that the demands of a technological civilization must be reduced to an absolute minimum and that further deviations from a natural way of life should be avoided.

I posed the following question to Dr.S.W.Tromp, director of the Biometeorological Research Centre,Leiden,the Netherlands: "Can it be justified on medical and psychological grounds to educate children in a windowless,artificially illuminated environment?" He replied in part:

> "There is little doubt,that someone who always works under artificial light,and especially children,will experience physiological difficulties,although these may not be immediately noticeable. There is also a possibility that their natural biological rhythm will be effected".

Jacob and Stück write about the possibility of an actual breakdown of the health of children as a result of continued interference with a child's biological rhythm. Physiological troubles may express themselves as sleeplessness, extreme irritability and eventually a nervous breakdown.Some of the human functions which seem to depend on a natural daily rhythm resulting from a subconscious observation of the natural environment are tactile co-ordination,attention span,concentration and digestion. As the daily and annual rhythms of man are the result of natural variations in light and temperature,man may not be in a position to ignore these rhythms on a long-term basis without doing himself serious harm.

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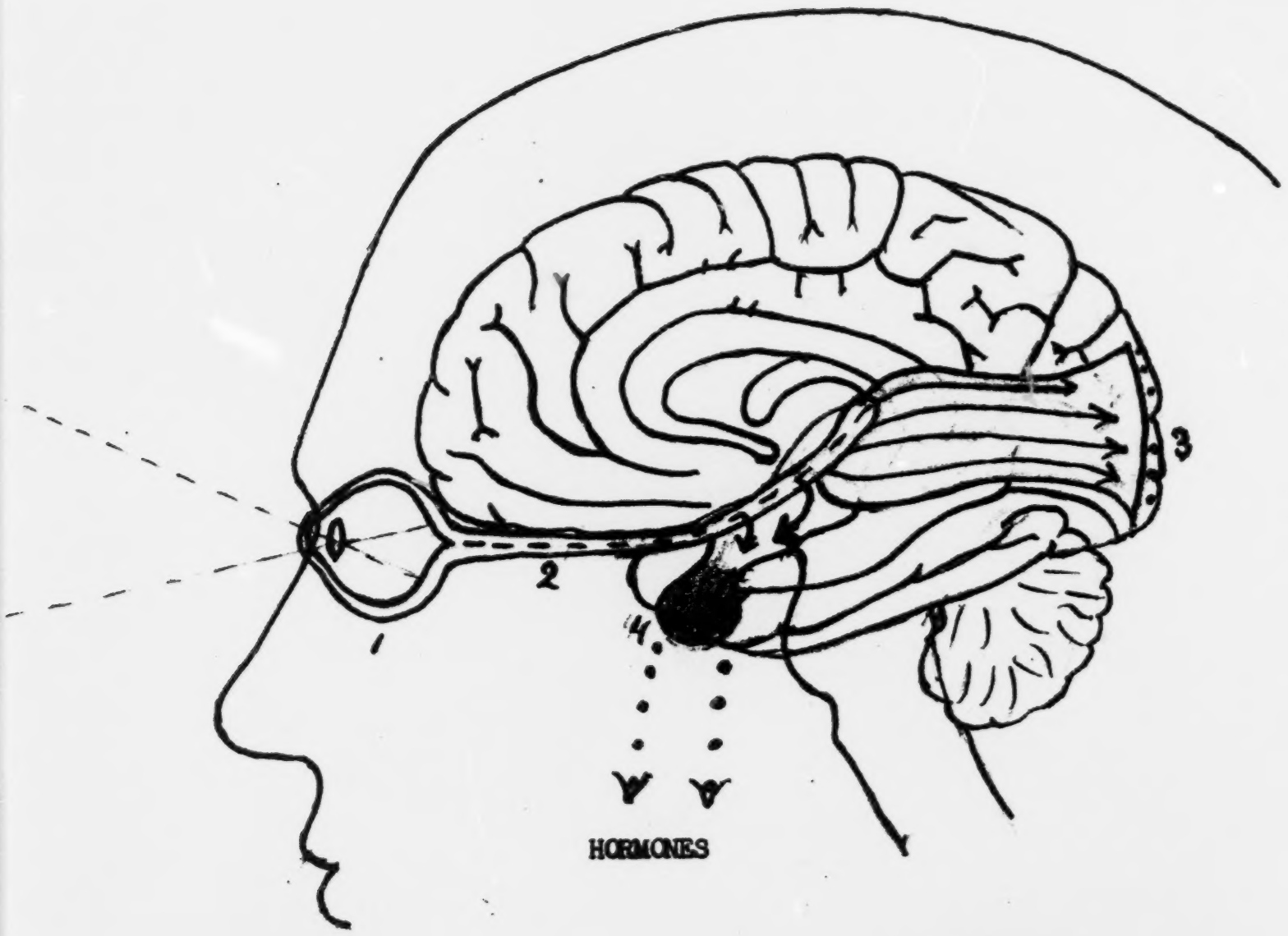
(11) "Lebens und Arbeitsbedingungen in Fensterlosen Räumen", Jacob and Stück, Arbeit und Leistung, November 1968.



Light energy received by the eyes (1) is transformed into nerve impulses which follow the optic nerve (2) to the midbrain and a system of fibres to the visual lobe (3) at the back of the head.
It is here that the brain provides mental images of what we see.

Light energy received by the eyes is also converted into nerve impulses which reach the hypothalamus and the pituitary or master gland (4).
The intensity, duration and wavelengths of light affect the hormone production of the pituitary gland and, therefore, the "biological clock".
This "clock" expresses itself through the daily rhythms of the digestive system, blood pressure and water metabolism.

Long term exposure to artificial light of constant wavelength and intensity is known to have undesirable physiological effects on some young people.

The Physiological Clock

E.Bunning who has spent decades studying the biological clocks of man and lower animals,published his findings in 1958 (12). He found that night-day cycles have a controlling influence on the rhythm of internal functions such as hormonal secretions,urinary excretions and digestion.

The periodicity of many internal functions is controlled via the eyes.It seems that changes in light intensity and wavelength as experienced in naturally lighted environments may be needed to synchronize internal rhythms.Physicians have repeatedly emphasized that disturbances of the human biological clock can result in diseases of organs such as the stomach and the liver.

Can man refuse to acknowledge his dependence on natural phenomena and remain healthy?

Sensory Deprivation

The trends point in a direction of a "school-day" from eight in the morning till five or six o'clock in the afternoon.As in many homes both parents are working for financial or other reasons,they have little time and energy for children,who are therefore transferred to schools or nurseries for ever longer periods of time. Pre-school enrichment programs,school breakfast, lunch,supper and after-school provision of study rooms are on the horizon and will soon be with us.

A windowless environment would mean sensory deprivation periods of eight to ten hours per day.Children might be excluded from daylight and sensory contact with the natural environment for most of the day. The results may be disruptions of the internal rhythms causing physiological and psychological disturbances.

It can no longer be denied that the human organism has evolved cellular rhythms in response to daily,monthly and annual fluctuations in the natural environment. (13)

(12) Die Physiologische Uhr, (The Physiological Clock),E.Bünning, Springer Verlag,Berlin,1958,1964.
(13) Biometeorology, S.W.Tromp,American Elsevier Publishing Co.

Zubek (14) has summarized studies dealing with the effects of extreme sensory deprivation on the learning of tasks such as the memorization of verbal material,word association and arithmetic.

Eleven percent of the studies indicate that extreme S.D. leads to improvements in certain learning tasks, sixty-one percent indicate no effect of S.D. on some forms of learning,while twenty-eight percent of the studies indicate definite impairment of learning. Extreme S.D. seems to affect the learning of complex tasks most.

Sensory deprivation in windowless classrooms may not be of statistical significance at this stage as children now spend five to six hours perday inside those classrooms and have recess and lunch breaks which are,hopefully,spent in the outdoors in physical activities.

There is,however,no doubt in my mind that the deprivation experienced by the elementary and secondary students now being "educated" in the large compact windowless penitentiary-like schools as found in some cities of Ontario has detrimental long-term effects on the outlook on life and education of our future taxpayers.

It should also be kept in mind that psychological research has indicated the importance of a stimulation of all senses for learning and motivation.

Psychologists experimenting with complete or partial deprivation of one or more senses have learned that sensory variety is

"not just the spice of life,but the bread of life".(14)

(14) Sensory Deprivations,edited by J.P.Zubek, Century Psychology Series,Appleton,Century and Crofts, New York,1969.

The Development of the Human Eye

The average human being is born farsighted and this farsightedness increases until the child reaches the age of seven or eight. In order to see distant as well as near-by objects young children must,therefore,continuously accommodate the eye.

From the age of eight till adulthood,farsightedness diminishes gradually until the normal adult condition of emmetropia is reached.The emmetropic eye requires no accommodation by the lens when focussing on an object more distant than twenty feet. In the ideal adult eye the process of accommodation is mainly required to focus nearby objects on the retina (15).

It should be kept in mind then that the normal elementary school pupil must continuously accommodate in order to read,write or draw.These activities are strenuous for most young eyes and account partly for the short attention span of many youngsters.

Reading and writing activities must be alternated with work or play requiring distant vision,thus allowing the muscles to relax. When about thirteen years old most students have nearly adult eyes,although the eyes in most cases continue to decrease in farsightedness. From the age of twenty years on the eyes are virtually adult and change very slowly.

Paul W.Seagers,school building consultant and professor of education,when discussing the development of the human eye states in part:

> "Pupils should be encouraged to follow practices which will minimize eye fatigue.One of the most effective is that of glancing about or out of doors at intervals during close work,such as reading,so as to change the accommodation of the eyes". (16)

In a report to a commission studying the desirability of windowless classrooms (17) Seagers states in part:

"I am of the opinion that...

1. all elementary classrooms should have windows.
2. in junior high schools definitely not less than sixty percent of the academic classrooms should have windows.
3. in senior high schools ..... a student in the average program should be in a space with windows not less than 20 percent of his time in school.".

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(15)Textbook of Ophthalmology,Sir W.Stewart,Duke-Elder, Henry Kimpton,London.
(16)Light,Vision and Learning, P.W.Seagers,Indiana University, Better Light,Better Sight Bureau,New York,N.Y.,1963.
(17)"A Report to the General Commission of the Indiana State Department of Public Instruction,P.W.Seagers,Oct. 1968.

The Interaction of Man and His Environment

Learning goes on all the Time
While One is actively awake.

William Heard Kilpatrick

As mental health,personality traits and outlook on life are the results of interactions between genetic make-up and environmental experiences,society must strive to create urban environments which favour optimal physical and mental development. From the moment of birth an individual's inherited characteristics are molded by the stimuli of home,church,school, and neighbor hood.

Educators and architects must,therefore,look at a schoolbuilding not only as a place where formal learning will take place,but should also consider the effect of the school design on the development of personality traits.

Human behavior is complex. And since individuals differ greatly in background,motivation and adaptation to social stress it is difficult to generalize and predict the effects of a windowless environment on the human mind and the human body.

Man has a remarkable ability to develop tolerance to conditions different from those under which he evolved.This has led to the belief that through technical innovations,he can endlessly modify his ways of life without risk to his mental or physical health. It should not be overlooked,however,that man can only adapt to a synthetic environment in so far as his genetic code permits. The limits that must be imposed on technological innovations are,therefore,not dependent on scientific knowledge,but on the physiological and psychological capabilities of man.

Some of the questions that we should ask ourselves are:

1. Does the school environment of the nineteen seventies still have to condition young people for life in army barracks,the mines and windowless factories or for a three-day work-week with creative indoor and outdoor pursuits for the remaining leisure time?

2. Exactly what are the psychological effects of long, straight halls lined with lockers,windowless classrooms and bells that determine when teachers and students can salivate,urinate,stretch their legs,close their books and stop or resume learning? Are all of the free young souls unable to adjust to these Pavlovian institutes indeed trouble makers or psychologically abnormal?

In my opinion the answers to many of the environmental problems posed by school design are available. It is imperative,however, to combine and synthesize the research findings of biologists,psychologists,biometeorologists,endocrinologists,ophthalmologists,lighting experts and finally those of engineers and architects.

The Consequences of Excessive Energy Consumption

The trend in the construction of schools in North America has followed the design of complex,energy-consuming equipment.It is characteristic of the prevailing engineering mentality to believe that all environmental problems can be solved through technological gadgetry. The side effects on man and the environment are usually overlooked.

The energy input into a compact windowless school for heating,lighting and ventilation is exhorbitant and, from an ecological viewpoint,unjustifiable.

Many architects and engineers seem to be unaware of the fact that a continued wasteful consumption of energy will lead to the exhaustion of the world's non-renewable resources within a few generations and that the waste-products released in the conversion of matter into energy will make the biosphere unfit for human life within decades.

All power consumption causes pollution and our excessive use of natural gas and electrical energy is now known to have caused unbalances in the air and waters of the earth. Singer writes that the carbon dioxide concentration in the atmosphere has risen from 290 to 320 p.p.m. in the last century and may reach 400 p.p.m. by the year 2000. (18) We are now also aware of an increasing release of other pollutants into the biosphere.

It is,therefore,in my opinion a waste of tax-payers money and ecologically unjustifiable to design and construct public buildings that cannot be used under average daylight and climatic conditions without the input of huge quantities of energy.

Bert Bolin,professor of meteorology,University of Stockholm,wrote recently:

> "The greatest disturbances of which we are aware are those now being introduced by man himself. Since his tampering with the biological and geo-chemical balances may ultimately prove injurious, even fatal, to himself,he must understand them much better than he does to-day.
> The story of the circulation of carbon in nature teaches us that we cannot control the global balances.
> Therefore we had better leave them close to the natural state that existed until the beginning of the Industrial Revolution.Out of a simple realization of this necessity may come a new industrial revolution.". (19)

(18)"Human Energy Production as a Process in the Biosphere". S.F.Singer,Scientific American,September,1970.
(19)"The Carbon Cycle",Bert Bolin,Scientific American, September 1970,p.132.

Summary

Some North American architects and engineers have tried to solve a number of technical problems through the design and construction of windowless or partly windowless public buildings. The synthetic environment thus created may be relatively satisfactory to the requirements of adults but,in my opinion,falls far short of satisfying the psychological and physiological needs of young people.

It is overlooked that the function of light is not limited to providing vision but that it also aids in the regulation of the hormonal balance and the biological clock. The growth and development of children's eyes requires frequent relaxation to compensate for the strain caused by focussing on nearby objects.According to many ophthalmologists this relaxation can best be provided by views from windows.

The science of biometeorology has provided insight in the human requirements of relative humidity,light and temperature fluctuations which cannot yet be met by artificially-created environments.

Windowless schools are primarily the result of a belief in the religion of short-term economics,the long-term cost of the fantastic energy requirements of yearround airconditioned buildings is just now becoming obvious to schoolboards. Windowless classrooms are contrary to the now prevalent educational philosophy which stresses the utilization of the man-made as well as the natural environment in the education of young people.

As oxygen,carbon dioxide , carbon monoxide and relative humidity monitoring devices, as well as automatic sprinkler systems are usually absent,multi-storey windowless buildings are in my opinion hazardous to the health of the occupants.

There is every reason to believe that our fantastically wasteful consumption of electrical energy has led to greatly increased costs,partly due to the necessity of controlling pollution and partly due to a relative scarcity of energy. Black-outs and brown-outs similar to those common in the more densely populated regions of the U.S.A. will also occur in Ontario in the nineteen seventies. It is in my opinion not in the interest of the taxpayer to construct public buildings which cannot be utilized without artificial light and ventilation under average daytime climatic conditions.

In order to provide our young people with schoolbuildings which are healthful in all respects,aesthetically satisfying and useful as community centres it may be imperative to have the design of each schoolbuilding evaluated by a multidisciplinary committee consisting of members with specialization in the fields of biometeorology,arcology,ophthalmology,psychology, education,the arts and caretaking.

Concluding Remarks

It would be a generalization to state that the physical degeneration of young people is being caused by environmental deficiencies resulting from an increasingly synthetic environment,which has brought about living conditions that are anything but healthful.

However,the supposition cannot be dismissed that the alarming increase of physiological and psychological illnesses,may be related, in a way still to be discovered,to living conditions at home and at school.

Ecologists suggest one possible solution: Man must recognize the necessity of not deviating too far and too fast from the natural environment in which he evolved.He must learn to appreciate that his health and ultimate survival depends on natural phenomena and processes only marginally aided by technological development.(20,21)

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I was very happy to discover,during my travels, that no truly windowless factories,offices and schools exist. The offices of administrative personnel and principals usually have fine windows and a good view.Is this to be able to report on the outside weather conditions to the less fortunate occupants of the building?

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One item which needs clarification is windows vs air conditioning.Many of the articles praising so-called better achievement in windowless schools emphasize not so much the windowless aspect but a correct thermal environment. I have found no evidence,however, that a thermal environment ranging in temperature from 60 degrees F. to 80 degrees F. either stimulates or hinders learning. However,if we wish to assume that air conditioning improves the educational output,then this can also be accomplished in a school with windows.There are numerous examples of these schools in North America. It seems that windowless areas are but another fad in the schoolbuilding business. For a number of years after the second world war,we couldn't get enough glass into a classroom for the feeling of openness.Now it is almost the opposite. The same designers that sold schoolboards glass-walled classrooms without providing effective external shading devices are now on the windowless-school bandwagon and design complex and expensive zoos that often resemble penitentiaries.Schoolboards that are being advised to build a windowless school or school addition should fully realize that the decision to build or not to build must be made on the basis of educational benefit and a healthy mental environment rather than on a construction cost or fad basis.

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I like to conclude with a quote from a letter recently received from a Canadian minister of education:

> " In general, I believe that the windowless classroom has not been a successful experiment except in special situations involving exceptional children or unusual laboratory facilities."

(20) Design with Nature, Ian L.McHarg, Natural History Press, Garden City, New York.
(21) Environment and Cultural Behaviour, Ecological Studies in Cultural Anthropology, P.Vayda, Editor, The Natural History Press, Garden City, New York, 1969.

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Schulbau von Heute für Morgen, Wilhelm Berger, Musterschmidt-Verlag, Göttingen, Berlin, Frankfurt, 1960.

"Effect of Temperature Upon Technical Training", Mayo G.D. Journal of Applied Psychology, vol.39, 1955, pp.244-249.

Recommendations

General Recommendations:

1. In the past the architect was the sole designer responsible for the development of the spatial environment in schools. His role has not diminished but must be re-evaluated and brought into proper perspective. Considering the knowledge now available about human behaviour in response to his environment the author recommends to the ministers of education of the provinces of Canada that in order to provide optimum human conditions in elementary and secondary schools that each design be studied by a multidisciplinary committee including at least:

   - a biologist with some specialization in human ecology
   - a psychologist with some specialization in learning environments
   - a biometeorologist with knowledge of endocrinology
   - an ophthalmologist,
   - artists, practicing teachers, senior students, janitors,
     a lighting engineer,
   - an architect trained in ecological principles.

2. Considering the global consequences of excessive energy consumption it seems irrational to design and construct public buildings which cannot be utilized under average daylight and other climatic conditions without the input of huge quantities of electrical energy for light and air conditioning.

   I recommend that elementary and secondary schools be designed to make maximum use of methods of natural illumination and ventilation and that artificial illumination and airconditioning be regarded as supplemental for reasons of economy, energy conservation and pollution reduction.

3. Due to an overemphasis on technology and engineering, human physiological and psychological needs have been overlooked in the design of many schoolbuildings. It has not been proven that the sensory deprivation of windowless classrooms aids the learning process.
   I have visited so-called compact schools with poorly-designed ventilating and air-conditioning systems and am seriously disturbed about the deteriorating environment in which some teachers and students are forced to work.

   I recommend that the Canadian Departments of Education establish a Section of Environmental Quality concerned with research on the effects of synthetic school environments on the physical and mental health of its occupants.

Recommendations

Regarding Windowless Schools and Classrooms

1. Considering the health hazards created by the unreliable performance of air-conditioning equipment in several compact schools I recommend that all existing windowless classrooms be equipped with:

   a. monitoring devices that measure the concentrations of oxygen, carbon monoxide and carbon dioxide,
   b. ultra-violet or other germ-killing devices in the air-stream of recirculated air to reduce the hazards of air-borne tuberculosis, influenza and other disease-causing organisms,
   c. an emergency exit in the form of a window, a door or a knock-out panel,
   d. sprinkler, fire and smoke-detection systems.

2. As students vary greatly in motivation and adaptibility to the synthetic environment of the windowless or virtually windowless classroom I recommend to the Ontario Institute for Studies in Education that a comparative study be made of the rate of absenteeism, the number of behaviour problems, the student drop-out rate and drug use in windowless schools and the more traditionally fenestrated schools.

3. Students and teachers working in windowless classrooms may experience lengthy periods of sensory deprivation which may affect their endocrine system. It may be desirable to provide them with frequent out-of-school education to counter-act possible harmful physiological or psychological effects. I recommend that the occupants of such institutes be permitted to participate in frequent outdoor education experiences in the form of sports and field studies.

4. A study of the cost of energy consumption of 24 Ontario schools has shown that the annual cost of heating, cooling and illuminating windowless classrooms may be from two to ten times as high as that of similar but fenestrated schools. (see addendum). The validity of this study, however, is limited due to the small number of schools investigated.
   I urgently recommend to the county schoolboards of Ontario to initiate studies concerning the annual cost of energy consumption (electricity plus coal, gas or oil) of the schools within their jurisdiction. The results should be collected and interpreted by the Division of School Planning and Building Research of the Ontario Department of Education.

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Glossary

Accommodation of the eye: A change in the shape of the lens of of the eye that focuses the image of an object on the retina. The process by which the eye changes focus from one distance to another.

Arcology. Architectural ecology.

Biological Clock. An internal timing device regulating periodic occurrences at the cellular as well as at the behavior levels. Examples are menstrual cycles, water excretion and digestion. The "clock" is often set by external stimuli such as fluctuations in temperature, light intensity and length of day.

Biometeorology. The science dealing with the influence of weather and climate on living organisms emphasizing the continuous interaction between the internal physiological processes in man and the perpetually changing weather and climatic conditions in the atmosphere.

Biosphere. That part of the earth in which life exists.

Ecology. The study of the reactions of living organisms, including man, to their environment. Includes the relationships between living organisms and their non-living environment.

Endocrine System. A system of glands that secrete substances called hormones directly into the blood. The thyroid gland is an example.

Emmotropia. The most common adult condition of the eye: images of distant objects can easily be focussed on the retina. Accommodation is required to bring nearby objects into focus.

Farsightedness. The ability to see distant objects well, but nearby objects seem out of focus. Common in adults. A vision defect caused by too short an eyeball or too flat a lens.

Fenestration. Windows and other means of controlling the entrance of natural light into a building.

Homeostasis. The principle of self-balance, may involve behaviour aimed at maintaining constant living conditions.
Also the tendency of the body to maintain a balance among internal physiological conditions such as temperature, sugar, air and salt.

Sensory Deprivation. I have broadened the traditional definition of S.D. to include experiences in windowless classrooms, submarines and spacecraft where the occupants are deprived of several normal sensori stimuli such as the fluctuations of daylight, views of the outside world, or certain sounds.

Stanford Achievement Tests. A series of tests aimed at evaluating a person's achievement as measured by classroom tests. They indicate what and how much he apparently has learned in a particular unit of study as his performance on a test is compared with that of his classmates. The tests tell relatively little about him as a person or a learner.

Synthetic Environment. The man-made environment of artificial light, air conditioning, steel, synthetic fibres, synthetic food, asphalt, concrete, D.D.T., insecticides, plastics etc.etc.

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Schools visited in connection with this Study

	Canada.
London, Ontario,	Winchester Sec.School.
Hamilton, Ontario	Seneca P.S.; Sir John A, MacDonald S.S.
Oxford County, Ontario	some 40 schools.
Delhi, Ontario	Delhi P.S.
R.Ouelle, P.Q.	Convent School.
Cap Chat, P.Q.	Ecôle de Notre Dame & E.de Sacré Coeur.
St.Charles de Capland, P.Q.	Regional Sec.S.
Dalhousie, N.B.	Regional Sec.S.
Shediac, N.B.	L.Robichaud Ecôle Polyvalente.
Kensington, P.E.I.	Regional Sec.S.,
Belfast, P.E.I.	Belfast E.S.
Port Hawksbury, C.B.I.	Centennial E.S.
Halifax, N.S.	St.Patrick's High School.
Chester, N.S.	Chester and Region H.S.
Lunenburg, N.S.	Lunenburg Elementary School, Regional S.S.
Middleton, N.S.	Middleton Regional H.S.
	U.S.A.
Saginaw, Michigan	Gen.McArthur H.S.
Crystal Lake, Ill.	several el.schools, outdoor education centre.
DeKalb, Ill.	N.I.U. University School.
Woodstock, Ill.	Woodstock Community H.S.
Dixon, Ill.	Dixon H.S.
Oregon, Ill.	Regional H.S. and elementary schools.
Chicago, Ill.	several inner-city and suburban el.schools.
	Western Germany.
Bremen. City.	several el.schools, sec.schools and school-country homes (Schullandheime)
	The Netherlands.
Wageningen	Technical S.S. (H.T.S.)
	M.A.V.O. Sec.School.
Breda	Domestic Science School; M.A.V.O. Sec.School.
Zwolle	Chr.Lyceum, (H.A.V.O.)
	Higher Technical Institute (H.T.S.)
	Great Britain.
Weathamstead, Herts.	Weathamstead S.S.
Woodstock, Oxfordshire	Woodstock Primary School, Woodstock S.S.
County of Oxford	several village schools.
Farmoor, Oxfordshire	Hill End Camp.
Buxton, Derbs.	White Hall Centre for Open Country Pursuits.

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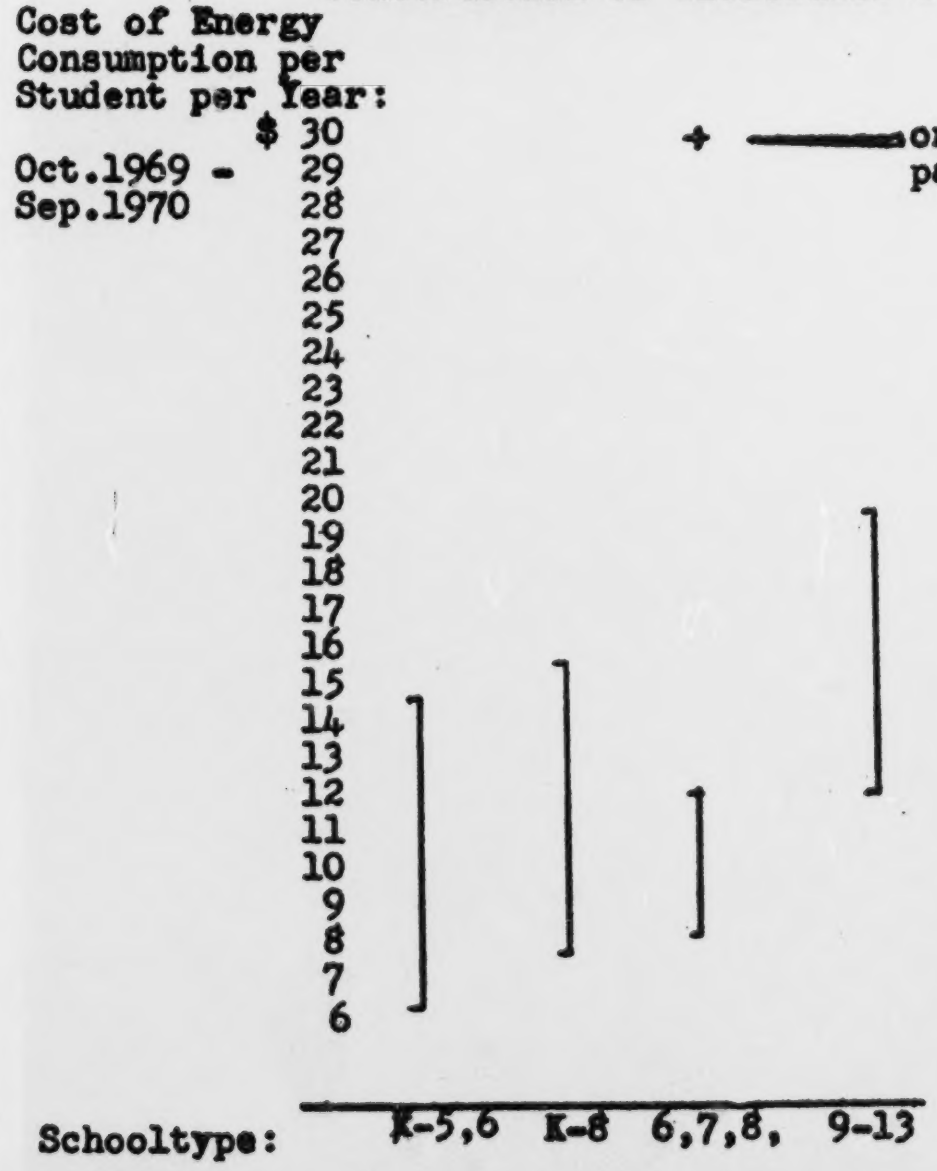
Summary of an Energy Consumption Study of 24 Schools

Aim of Study: To compare the cost of energy consumption of 24 schools varying greatly in design and date of construction. For the purpose of this study E.C. was defined as the cost of electricity plus that of oil, coal or gas over a 12 months' period divided by the number of students attending the school.

Limitations of the Study: (a) the observations are limited to a one year period. (b) the observations made were limited to 24 schools.

Observations: Energy Consumption generally varied inversely with the age of the school. In other words: the more recent the date of construction of the school, the higher the annual cost of energy consumption, in spite of the use of lower ceilings, improved insulation materials, reduced window areas and the construction of windowless classrooms.



E.C. per Student per Month of Four Senior Public Schools	1*	2	3	4
Jan.1970	$ 2.26	1.67	1.08	1.11
Aug.1970	$ 2.77	0.20	0.23	0.10

* electrically heated, air-conditioned, compact, partly windowless school.

Schools 2,3 and 4 are of more traditional design, oil-heated, large window areas.

Conclusions:

1. The E.C. of the electrically-heated and air-conditioned, compact public school was 2 to 20 times as high as that of other schools of comparable size and usage.
2. The E.C. of the electrically-heated and air-conditioned senior public school was much higher than that of the large composite secondary schools with shops, welding equipment etc.

Schoolboards intending to conduct a similar study may contact me at Box 536, Woodstock Ont.